Feeding habits of the fish *Megalops cyprinoides* Broussonet, in the Cooum backwaters, Madras

BY

THAVAMANI J. PANDIAN[1]

Zoological Research Laboratory, University of Madras, Madras

(*With three text-figures*)

The feeding of the fish, *Megalops cyprinoides* seems to be concentrated on a few key species so that within the community only the populations of these species suffer predation. Changes in feeding succession in relation to size are related not only to food preferences but also to availability of food. Feeding intensity, as assessed from the stomach contents, was more or less uniform throughout the year. It varied between 0·7 and 0·8% body weight. Because of the uniform temperature conditions prevailing in the tropics, temperature effects on feeding intensity seems to be less pronounced. A single peak observed during the monsoon months is attributed to a greater abundance of food in the environment. In some months, the fish stops feeding during the day time and probably temperature fluctuations may have some bearing on the feeding periodicity.

INTRODUCTION

It is well known that the fishes feed intensively during spring and summer in temperate waters (Allen 1940). This fact has been related to the abundance of food supply by Hardy *et al.* (1936) and later by Ricker (1937) to the combined effect of food supply and temperature. In tropical waters of India, however, temperature is uniformly higher than the maxima in higher latitudes and the seasonal differences are less marked ; rather uniform organic productivity prevails throughout the year (Ramamoorthy 1953 ; Bogorov 1960). To what extent such relative uniformity in food supply and temperature conditions influence the intensity of feeding has received very little attention. The present paper reports on the feeding habits of a tropical fish, with special reference to the factors influencing the feeding intensity.

---

[1] Present address: Zoology Department, University of Bangalore, Bangalore.

Material and Methods

Megalops cyprinoides Broussonet (Elopidae) was collected from the River Cooum, Madras, which is a shallow canal of 50 metre width and 2 metre depth, receiving in its course sewage effluents. It reaches the sea close to the University Laboratory. Most of the year it is separated from the sea by a sand bar. With the onset of monsoon, the water level rises and the sand bar breaks, thus allowing the stream to flow into the sea in late October or early November for a period of about 3 to 5 weeks. During the rest of the year the Cooum is more or less stagnant. For topographic and hydrographic details consult Ganapati (1964).

M. cyprinoides is distributed from Madagascar to the East Indies. The juvenile fishes migrate into the backwaters of the east coast of India, where they grow up to 300 to 400 gm. in weight but do not attain maturity in these waters of low salinity (Job & Chacko 1947), and are said to return to the sea. Larger fishes weighing 600 gm. or more, have not so far been observed in the backwaters. The fish is available in the Cooum backwaters in large numbers throughout the year.

The food and feeding habits of the fish were studied from July 1963 to June 1964 by analysing the stomach contents of 403 specimens measuring 4·3 cm. to 31·7 cm. in standard length. Specimens were collected in the early hours of the morning with a cast net operated from a catamaran which could catch about 30 to 40 individuals within an hour or so. The fishes were brought to the laboratory, weighed and volume of stomach contents in relation to the size of the fish was determined. The various food contents were then analysed qualitatively and quantitatively and the volume of different food fractions was measured by the displacement method (see Hynes 1950 ; Pillay 1951).

Observations

Crustaceans, insects and fishes formed the major food items of the fish *M. cyprinoides*. The crustaceans included, copepods *Cyclops bicolor*, cladocerans, *Daphnia* sp. and the prawn, *Metapenaeus monoceros* and insects, corixid bugs, *Micronecta scutellaris* and *Notonecta* sp., aquatic beetles *Dysticus* sp., midge larvae and pupae of *Chironomus* sp., and nymphs of *Platycenemus* sp. Fish included the fry of *Chanos*, *Elops* and *Therapon* and the juveniles of *Mugil* and the adults of the genera *Barbus*, *Gambusia* and *Mystus*. Other items of minor importance were the eggs of crustaceans and rotifers and a number of species belonging to the genus *Brachionus*. Stray occurrences of megalopa larvae of brachyuran crabs and the malacostracans *Cirolina* and *Grandierrella* were also recorded, especially during the rainy season. Table 1 gives the

seasonal variations in the composition of different food fractions (Fig. 1). The year can be arbitrarily divided into three periods namely,

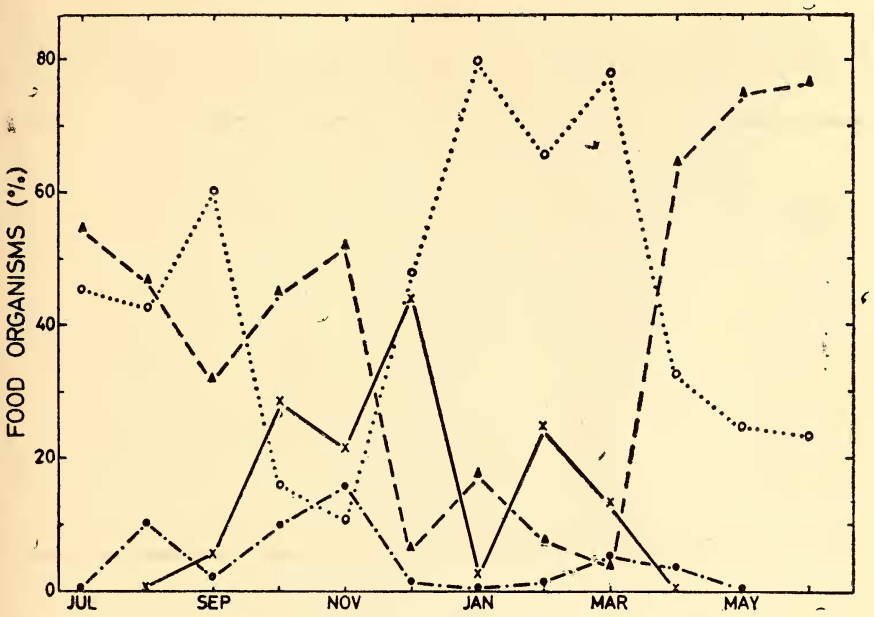

Fig. 1. Monthly variations in the food composition of *Megalops cyprinoides* collected from July '63 to June '64 in the Cooum backwaters, Madras.

Key : Δ — — Δ = Crustaceans ; o....o = Insects
× —— × = Fishes ; ●—o—o—o● = Miscellaneous

Rainy (August to November), Cold (December to March), and Hot (April to July) Seasons with temperature characteristics of 27°, 25°, and 30°C. respectively. The different food fractions characteristic of a period (expressed in % of total food) have been considered as basic, secondary and incidental food (Nikolsky 1963). It may be seen from Table 2 that intensive feeding at any given period centred around a few key species only. This observation conforms with those of Shorykin (1939) and Darnell (1961), who have shown that in a community only a few species suffer heavy losses from predatory fishes.

In the present investigation, only fishes measuring 4·5 to 31·7 cm. in length were available for study. A comparison of the food composition of different size groups indicates that there was no marked difference in the food preference in relation to size of the fish. The smallest *M. cyprinoides* found in the Cooum backwaters were 4·5 cm. in length ; these were feeding mainly on planktonic organisms and *Chironomus* and rarely on the fish *Gambusia*. A similar observation

has been reported in the case of larval and juvenile tarpon *Megalops atlantica* by Harrington & Harrington (1960).

TABLE 1

MONTHLY VARIATIONS IN THE PERCENTAGE COMPOSITION OF MAJOR FOOD ITEMS OF *Megalops cyprinoides* COLLECTED FROM THE COOUM BACKWATERS

Month & Year	Food			
	Crustaceans (%)	Insects (%)	Fishes (%)	Miscellaneous (%)
July '63	54·64	45·36	—	—
Aug. '63	46·90	43·00	—	10·10
Sep. '63	31·94	60·24	5·77	2·24
Oct. '63	45·18	16·12	28·61	10·08
Nov. '63	51·76	10·60	21·98	15·66
Dec. '63	6·43	48·11	43·92	1·54
Jan. '64	17·40	79·80	2·80	—
Feb. '64	7·82	66·08	24·80	1·30
Mar. '64	3·93	79·80	13·41	2·80
Apr. '64	64·31	32·45	—	3·24
May '64	75·03	24·97	—	—
June '64	76·67	23·33	—	—

TABLE 2

SEASONAL VARIATIONS IN THE FOOD COMPOSITION OF *Megalops cyprinoides*

Period	Basic food (25 to 75% of total)	Secondary food (5 to 25% of total)	Incidental food (less than 5% of total)
Aug. to Nov. (Rainy Season Temp. 27°C.)	*Micronecta*, *Metapenaeus*	*Cyclops*, *Elops*, *Chanos*, *Therapon*	*Dysticus*, *Brachionus*
Dec. to Mar. (Cold Season Temp. 25°C.)	*Chironomus* larvae & pupae	*Gambusia*, *Barbus*, nymphs of *Platycenemus*	*Notonecta*
Apr. to July (Hot Season Temp. 30°C.)	*Cyclops*	*Micronecta*, Ostracods	*Brachionus*

For a period of about seven weeks during the rainy season (from the middle of October till the early December), when the sand bar between the Cooum and the sea breaks, a large variety of larval and juvenile forms of marine animals migrate into the Cooum, thereby increasing the quantity and variety of food organisms available (Panikkar & Aiyar 1939). To ascertain if there was selective feeding among the different size groups on these food organisms, the data obtained for the

months of October, November, and December have been pooled together. Four size groups, with a size range of 4·3-9·9 cm., 10·0-14·9 cm., 15·0-24·9 cm., and 25·9-30·3 cm. were averaged and the mean sizes obtained were 8·3, 12·5, 17·0, and 27·7 cm. in length, respectively, (Table 3). It can be seen from Figure 2 that with an increase in size, there is a marked preference towards fish-food. Insects and crustaceans, which formed more than 35% each in the first and second size groups, are correspondingly reduced in the third and fourth size groups. Thus, with increasing size, the fish passes through the feeding succession : crustaceans → insects → fishes. Similar feeding succession has also been observed for carnivorous fishes like *Esox lucius* (Hunt & Carbine 1951). Difference in food preferences among the different size groups may be an adaptation for an effective utilization of the increased range of food supply (Nikolsky 1963).

The different food items of *M. cyprinoides* were arbitrarily divided into microfauna comprising planktonic organisms and macrofauna consisting of prawns, insects and fishes. There was a remarkable increase in the macrofauna components eaten during the period, September to March, accompanied by a corresponding decrease in microfauna (Table 4 ; Fig. 3). These changes can be attributed to the ease with which the prey can be captured. For instance, fully ripe females of *Mystus* and *Barbus* were often eaten in October and December, respectively, but were absent in the stomach in other months, although they were present in the Cooum. As the gonads ripen *Mystus* (Pandian in press) and *Barbus* females, become sluggish and are perhaps easily caught during October and December. The frequent occurrence of isopods and amphipods in the stomach of the fish only during November and December and not in other months, indicates that they move to the surface from the muddy bottom because of flooding.

TABLE 3

FOOD PROGRESSION IN DIFFERENT SIZE GROUPS OF *Megalops cyprinoides* COLLECTED FROM OCTOBER TO DECEMBER 1963 IN THE COOUM BACKWATERS

Size group (body length cm.)	Total examined	Crustaceans (%)	Insects (%)	Fishes (%)	Miscellaneous (%)
8·3	10	52·23	11·57	18·10	17·10
12·5	32	42·92	36·25	11·30	9·53
17·0	75	33·31	21·59	40·54	4·56
27·7	4	34·80	11·45	53·75	—

During the month of May, 14 individuals collected had empty stomachs, but their intestines were more or less gorged with food. The

absence of food in the stomach of the fishes collected during this period is probably due to their feeding at night, and the food having passed

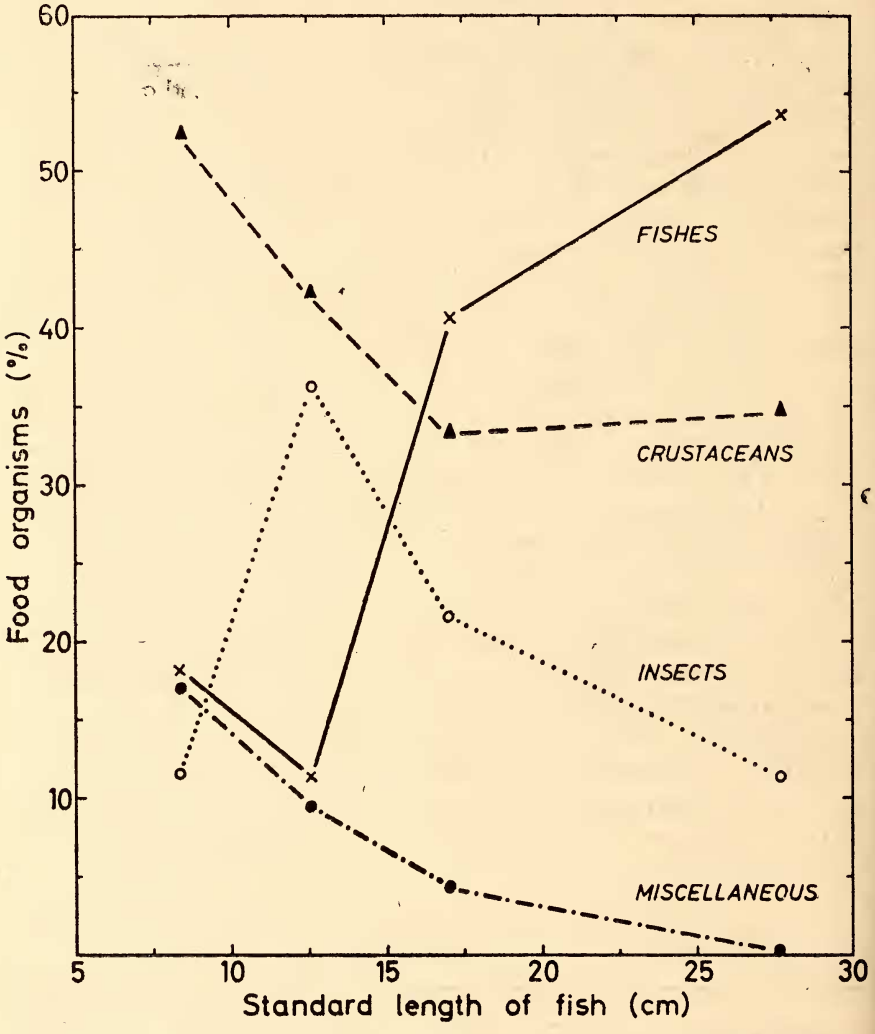

Fig. 2. Food progression in different size groups of *Megalops cyprinoides* collected from October to December 1963 in the Cooum backwaters, Madras.

into the intestine at the time of collection (6 a.m.). This assumption is supported by the observation that collections made during the night (11 p.m.) during this period showed stomachs full of copepods, ostracods, corixid bugs etc. Similar results were recorded until the end of June. The plankton collection made in the area during the day revealed that all the items consumed by the fish at night were present in the plankton.

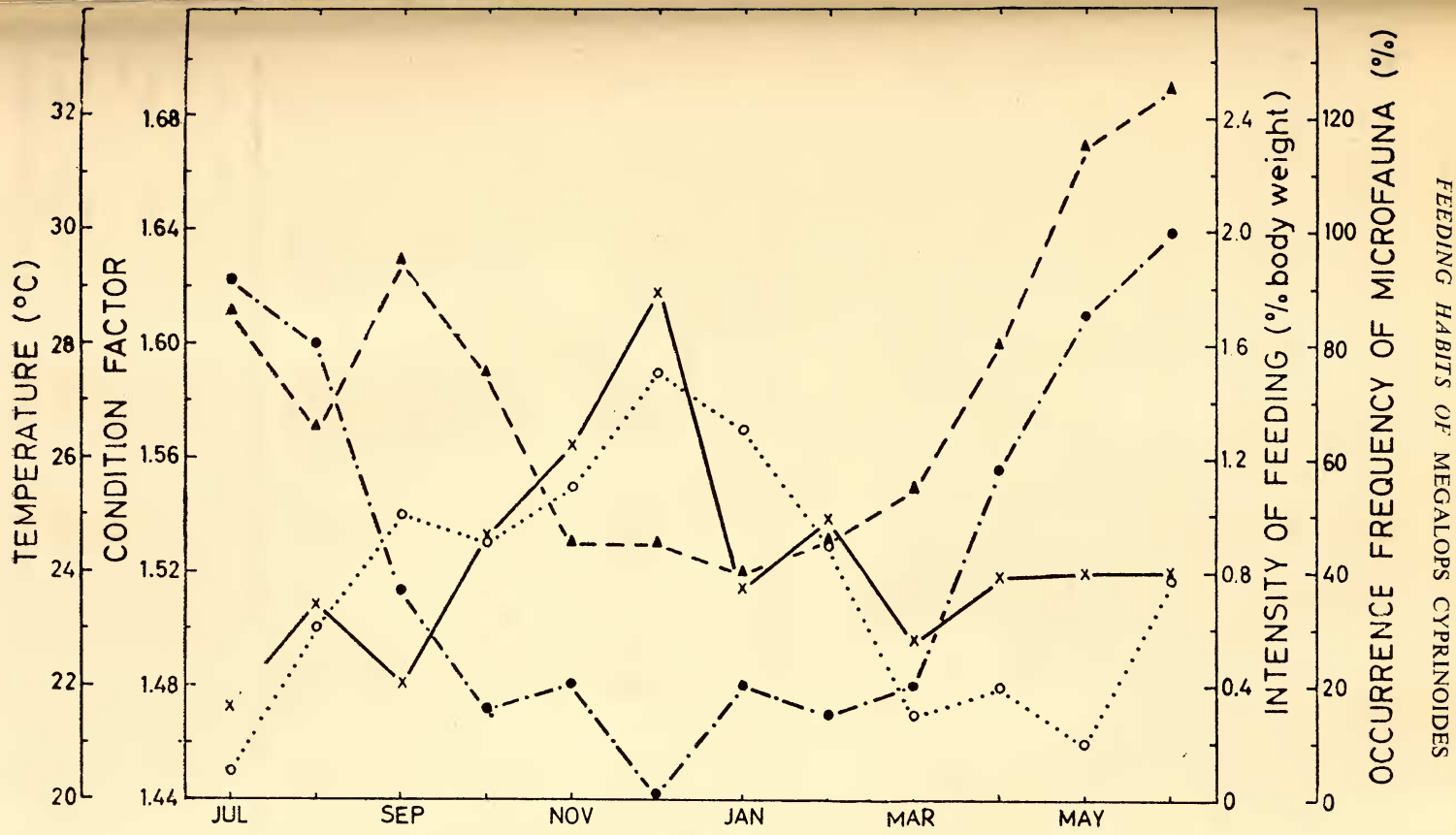

Fig. 3. Monthly variations in the intensity of feeding during the period July 1963 to June 1964.

(× ———— ×), occurrence frequency of microfauna (● — o — o ●). and condition factor (o . . . . . o) of the fish *Megalops cyprinoides* and surface temperature (△ — — — △) of the Cooum back waters, Madras.

Therefore, it may be inferred that the fish did not feed during the day not because of the non-availability of food, but for some other reasons, which are not clear owing to lack of data on turbidity of water, diurnal migrations of planktonic organisms and other factors. In Canadian waters, cessation of feeding due to higher temperature during the day and resumption of feeding during the night by the juveniles of *Salmo salar* has been reported by Hoar (1942).

The amount of food consumed by *M. cyprinoides* varied during the different months of the year (Table 4 ; Fig. 3). Feeding intensity, was low in July (0·318% body weight), and increased steadily throughout the rainy season reaching a maximum of 1·784% body weight in December. It declined (0·742% body weight) in January, but again increased to 0·991% body weight in February and remained at about 0·8% body weight throughout the summer months. The fish fed intensively from October to December. In other months, the intensity of feeding was more or less uniform ; the variations being within a range of 0·7 to 0·8% body weight.

TABLE 4

MONTHLY VARIATIONS IN THE AMOUNT OF FOOD CONSUMED, OCCURRENCE FREQUENCY OF MICROFAUNA, CONDITION FACTOR OF *Megalops cyprinoides* AND CHANGES IN SURFACE TEMPERATURE OF THE COOUM BACKWATERS

Month & Year	Total examined	Food consumed (% body wt.)	Occurrence frequency of microfauna (%)	Condition factor (K)	Temperature of the Cooum (°C.)
July '63	11	0·318	90·90	1·45±0·15	28·5
Aug. '63	39	0·683	79·61	1·50±0·10	26·5
Sept. '63	35	0·392	37·15	1·54±0·14	29·5
Oct. '63	38	0·908	15·79	1·53±0·15	27·5
Nov. '63	39	1·246	20·51	1·55±0·19	24·5
Dec. '63	52	1·784	0·00	1·59±0·17	24·5
Jan. '64	44	0·742	20·45	1·57±0·14	24·0
Feb. '64	39	0·991	15·38	1·53±0·15	24·5
Mar. '64	30	0·558	20·00	1·47±0·07	25·5
Apr. '64	34	0·780	58·00	1·48±0.04	28·0
May '64	22	0·799	85·00	1·46±0·08	31·5
June '64	20	0·785	100·00	1·52±0·08	32·5

Intensive feeding, as during the monsoon period from October to December may be accompanied by a change in growth of the fish. The mean condition factor of *M. cyprinoides* as seen from Table 4, steadily increased throughout the rainy season, reaching a maximum of 1·59 in December. It then declined gradually during the cold season and remained more or less low during the hot season. Further, Figure 3 shows that the trends obtained for the condition factor and the feeding

intensity are almost parallel to each other, indicating the effect of fluctuations in the food supply, not only on the consumption of food but also its resultant effect on the growth of the fish.

During the period of rapid growth, fishes and insects formed a major proportion of the diet of *M. cyprinoides*. Hunt & Carbine (1951) showed that an acceleration of growth of the fish *Esox lucius* is associated with its change over to fish diet. The selection of larger food organism by *M. cyprinoides* during the period October to March (Table 4) is significant as it helps the fish in cutting down the energy expenditure by capturing fewer prey (see also Allen 1935 ; Nikolsky 1963). During this period the condition factor of the fish was more than 1·5 (Fig. 3). Moreover, Pandian (1967b) showed that the conversion rates of protein and total food in *M. cyprinoides* is faster in individuals fed on *Gambusia affinis* than those fed on *Metapenaeus monoceros*. In the present study, the growth rate of *M. cyprinoides*, as indicated by the condition factor, is faster during the rainy season when *Gambusia* and other small fishes formed the main food than during the pre-monsoon period when *Metapenaeus* and other crustaceans were taken. During summer, the fish feeds less and in most cases ostracods formed an important food source. They were, however, not easily digested, since most of the ostracods observed from the rectal content were intact with bivalved carapace. Gerking (1962) reported that ostracods were found similarly in the lower part of the intestine of *Lepomis macrochirus*. Apparently, ostracods so common in the stomach of *M. cyprinoides* during the summer months have little food value to the fish, and this may account for the relatively lower value of the condition factor during these months.

Discussion

It is seen that the quantity of food consumed by *M. cyprinoides* was more or less uniform except for a marked increase during the period October to December. Although previous studies, Job (1940), Vijayaraghavan (1950, 1951a, b, 1953) and Kuthalingam (1955a, b, 1956a, b) have been limited to the species composition and to the seasonal changes of the diet of a number of coastal water fishes of Madras, their data indicates a similar feature as has been observed in the present study. A point to be noted is that the intensity of feeding, observed in *M. cyprinoides* is not as pronounced as one finds in temperate fishes. It is known that the intensity of feeding is influenced by the food supply, temperature, and reproductive cycle of the fish (Ricker 1946). In the present study, feeding habits refer to immature forms since mature *M. cyprinoides* do not occur in the brackish waters of the Cooum. Therefore, nothing can be said of the influence of breeding cycle on the feeding rhythm. The surface water temperature of the Cooum is quite high and

varies from 24° to 32°C. seasonally. Whereas, in temperate waters very low winter temperature may reduce or even stop feeding in fishes (Moffett & Hunt 1943 ; Ricker 1946), tropical fishes like *M. cyprinoides* enjoy relatively constant and warm temperature conditions and it appears that temperature has no bearing on the intensity of feeding in *M. cyprinoides*. Therefore, increase in feeding intensity observed from October to December in the fish is attributable to the changes in food supply in the habitat, because of the breaking of the sand bar at the mouth of the river.

M. cyprinoides of 1 gm. weight when fed on prawn *Metapenaeus monoceros* in the laboratory consumed 9·2% body weight/day and with increasing size of the fish, the feeding rate decreased to 1·8% body weight/day in 150 gm. individual, (Pandian 1967a). Considering this fact, the quantity of food (0·8 to 1.8% body weight) consumed by the fish collected in the Cooum is low. One of the possibilities seems to be that fishes feed more than once in the natural habitat. In fact it has been recently emphasized that intensity of feeding must be based not only on the quantity of food found in the stomach at the time of observation but also on the rate of digestion (Bajkov 1935) and on the frequency of feeding (Darnell & Meierotto 1962). In view of the difficulties in making continuous observations over a period to count the frequency and the limitations encountered in applying the data obtained for digestion rates in the laboratory to the fishes collected in the Cooum, the present study has been confined to the observations on the stomach contents alone. Finally, it can be seen that it is more important to study the efficiency and rate at which the food ingested is converted for growth in natural habitat by the fish than to consider the various aspects influencing the frequency of feeding and digestion rate. Allen (1940, 1941, 1951) and Benson (1953) have combined studies, such as those mentioned above, in relation to the condition factor. The changes observed for feeding intensity and those of condition factor of *M. cyprinoides* were parallel to each other. It is assumed that the results obtained for intensity of feeding based on the stomach contents are reasonably reliable and that additional effects due to changes in digestion rate and frequency of feeding would not alter the main trends observed.

Acknowledgements

This paper formed part of a Ph.D. thesis submitted to the University of Madras. Thanks are due to Prof. G. Krishnan and Dr. S. V. Job for guidance. I am indebted to Prof. O. Kinne, Director of the Biologische Anstalt Helgoland, Hamburg, for offering valuable criticism and improving the manuscript. I also thank my colleagues Miss

D. J. Colbourn and Dr. A. B. Wagh for their help. Fellowship awarded to me by the CSIR, India, is gratefully acknowledged.

References

Allen, K. R. (1935) : The food and migration of the perch (*Perca fluviatilis*) in Windermere. *J. Ani. Ecol.* **4** : 264-273.

——— (1938) : Some observations on the biology of the trout (*Salmo trutta*) in Windermere. ibid. **7** : 333-349.

——— (1940) : Studies on the biology of the early stages of the salmon (*Salmo salar*) : 1. Growth in the river Eden. ibid. **9** : 1-23.

——— (1941) : Studies on the biology of the early stages of the salmon (*Salmo salar*) : 3. Growth in the Thurso river system, Caithness. ibid. **10** : 273-295.

——— (1951) : The Horokiwi streams. A study of trout populations. *Fish. Bull. Wellington, N.Z.* **10** : 1-231.

Bajkov, A. D. (1935) : How to estimate the daily food consumption of the fish under natural conditions. *Trans. American Fish. Soc.* **65** : 288-289.

Benson, N. G. (1953) : Seasonal fluctuations in the feeding of brook trout in the Pigeon river, Michigan. ibid. **83** : 76-83.

Bogorov, B. G. (1960) : Perspectives in the study of seasonal changes of plankton and of the number of generations of different latitudes. In : Perspectives in Marine Biology, Ed. by A. A. Buzzati—Trquerso, Uni. Calif. Press, Berkley, 145-158.

Darnell, R. M. (1961) : Trophic spectrum of an estuarine community based on studies of Lake Pontochartrain, Louisiana. *Ecology* : **42** : 533-568.

———, & Meierotto, R. R. (1962) : Determination of feeding chronology in fishes. *Trans. American Fish. Soc.* **91** : 313-320.

Ganapati, S. V. (1964) : A hydrobiological study of the River Cooum in Madras, south India with special reference to fisheries. *Arch. Hydrobiol.* **60** : 200-224.

Gerking, S. D. (1962) : Production and food utilization in a population of bluegill sunfish. *Ecol. Monogr.* **32** : 31-78.

Hardy, A. E. *et al.* (1936) : The ecological relation between the herring and the plankton investigated with the plankton indicator. *J. mar. biol. Assoc., U.K.* **21** : 147-291.

Harrington, R. W. Jr., & Harrington, E. S. (1960) : Food of larval and young tarpon, (*Megalops atlantica*). *Copeia*, (1960): 311-319.

Hoar, W. S. (1942) : Diurnal variations in feeding activity of young salmon and trout. *J. Fish. Bd. Canada*, **6** : 90-101.

Hunt, B. P., & Carbine, W. F. (1951) : Food of young pike, *Esox lucius* L. and associated fishes in Peterson's Ditches, Hughton Lake, Michigan. *Trans. American Fish. Soc.* **80** : 67-83.

Hynes, H. B. N. (1950) : The food of fresh water sticklebacks (*Gasterosteus aculatus* and *Pygosteus pungitius*) with a review of methods used in studies of food of fishes. *J. Ani. Ecol.* **19** : 36-58.

Job, T. J. (1940) : An investigation of the nutrition of the perches of Madras coast. *Rec. Indian Mus.* **42** : 289-364.

——— & Chacko, P. I. (1947) : Rearing of salt water fish in fresh waters of Madras. *Indian Ecol.* **2** : 1-9.

Kuthalingam, M. K. D. (1955a) : Food and feeding habits of juvenile and adults of four fishes of Madras. *J. Madras Uni.* (B) **25** : 235-253.

——— (1955b) : The food of horse-mackerel *Caranx*. *Current Sci.* (1955) : 416-417.

——— (1956a) : The food of two grey mullets of Madras. *J. Madras Uni.* (B) **26** : 465-478.

——— (1956b) : The food and feeding habits of some Madras fishes. ibid. **26** : 465-478.

Moffett, J. M., & Hunt, B. P. (1943): Winter feeding habits of bluegills *Lepomis macrochirus* (Rafinesque) and yellow perch, *Perca fluvescens* (Mitchell) in Cedar Lake, Wastnaw County, Michigan. *Trans. American Fish. Soc.* **73** : 231-242.

Nikolsky, G. V. (1963) : The ecology of fishes. Translated from Russian by L. Birkett. Academic Press, New York.

Pandian, T. J. (1967a) : Intake, digestion, absorption and conversion of food in the fishes *Megalops cyprinoides* and *Ophicephalus striatus*. *Mar. Biol.* **1** : 16-32.

——— (1967b) : Transformation of food in the fish *Megalops cyprinoides*. ibid. **1** : 61-65.

——— (in Press) : Feeding and reproductive cycles of the fish *Mystus gulo* in the Cooum backwaters, Madras. *Indian J. Fish.*

PANIKKAR, N. K. & AIYAR, R. G. (1939) : Observations on breeding in brackish water animals of Madras. *Proc. Ind. Acad. Sci.* (B), **9** : 343-364.

PILLAY, T. V. R. (1951) : A critique on the methods of study of food. *J. zool. Soc. India*, **4** : 185-210.

RAMAMOORTHY, S. (1953) : Hydrobiological studies in the Madras coastal waters. *J. Madras Univ.* (B), **23** : 148-163.

RICKER, W. E. (1937) : The food and food supply of sockeye salmon (*Onchorhynchus nerka* Walbum) in Cultus Lake, British Columbia. *J. Biol. Bd. Canada*, **5** : 450-468.

——— (1946) : Production and utilization of fish populations. *Ecol. Monogr.* **16** : 373-391.

SHORYKIN, H. A. (1939) : The food and food relationships of some benthophagous animals of the North Caspian Sea. Pitarae i pishcheye Vzaimootoshenisrybkas puskono moria. Food Industries Press.

VIJAYARAGHAVAN, P. (1950) : Food factor and migration of a few fishes of the Madras coast. *J. Madras Uni.* (B) **19** : 59-68.

——— (1951a) : Food of the ribbon fishes of Madras. ibid. **21** : 81-95.

——— (1951b) : Food of rainbow sardine *Dussumeriea acuta* (Cuv. & Val.) ibid. **21** : 282-287.

——— (1953) : Food of sardine of Madras coast. ibid. **23** : 29-39.